
# A joint analysis of crop production trends in Sahel using MODIS NDVI time series, crop modeling and statistic data

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GLOBAL VEGETATION MONITORING AND MODELING

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# Background of the study

## Food security in West Africa

West Africa is characterized by:

- A strong climate variability in space and time

- High population growth rates

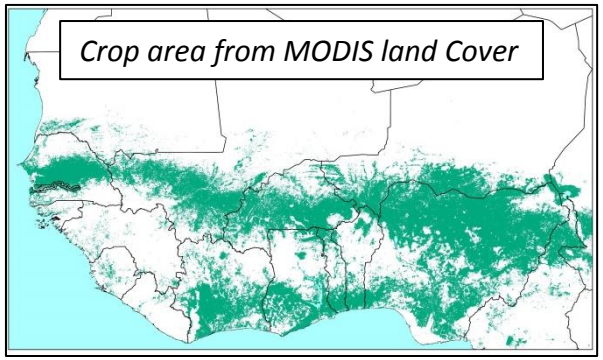
→Impacts on agricultural production and on food security

**Challenge of West Africa :** Enhance knowledge on crop production dynamics both at regional and local scale

# Background of the study

## Agricultural monitoring in West Africa


- Crop conditions and trends
- Crop area
- Crop type



# Background of the study

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Remote Sensing

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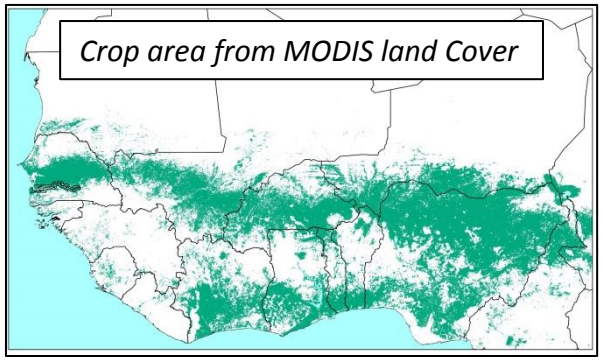
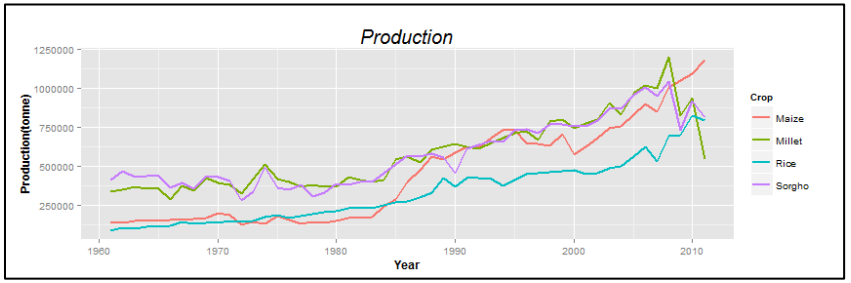
Agricultural statistics

- Crop production
- Surface harvested
- yield

Aggregated data!



# Background of the study

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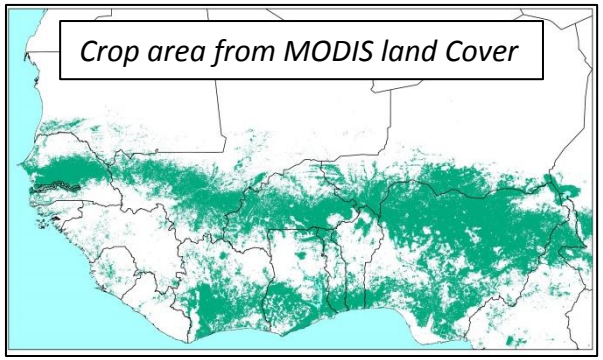
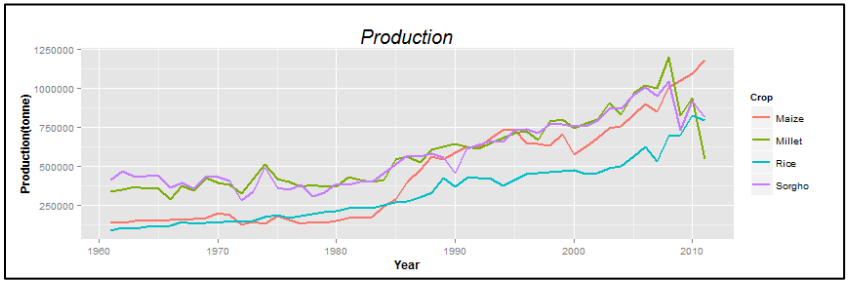
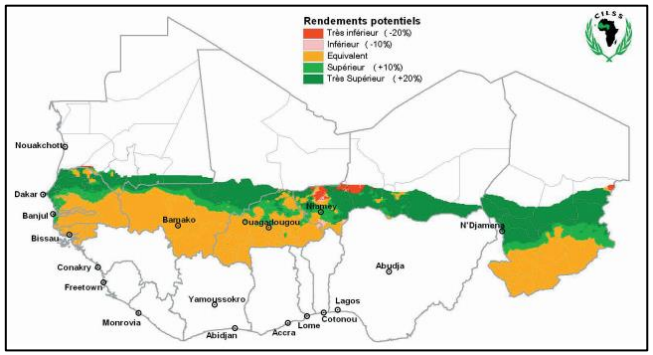
**Crop modeling**

- Yield prediction
- Biomasse prediction
- LAI …




*Potential millet yields for the rainy season 2012 (Agrhymet, August 2012)*

## Objectives of the study

**Question addressed:**

*What are the crop production dynamics in Sahel?*

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*What are the crop production dynamics in Sahel?*

## By performing a joint analysis of :

1. NDVI trends from remote sensing within the crop domain
2. Yield and biomass output trends from a crop model
3. Statistic data



# Normalised Difference Vegetation Index : NDVI

## Data

- NDVI product : MODIS MOD13Q1
- Sensitive to vegetation and its conditions
- Correlated to LAI, FAPAR and vegetation primary production

→ NDVI = proxy for vegetation greeness and biomass production

**Hypothesis** : NDVI increase with green plant biomass

Data & Methods



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## Methods

1) **Extraction of the crop domain** : Application of **an averaged crop mask** (MODIS Land Cover Product) on **annualy integrated NDVI** time series

2)**Trends** analysis by OLS (Ordinary Least Square Regression)

**3) Anomalies**



# *In situ observations from crop model and statistic data – Case study of the Kollo department (Niger)*

## Statistic data

**Millet Yield** – Aggregated at the Kollo department scale: 2000-2010 (AGRHYMET)

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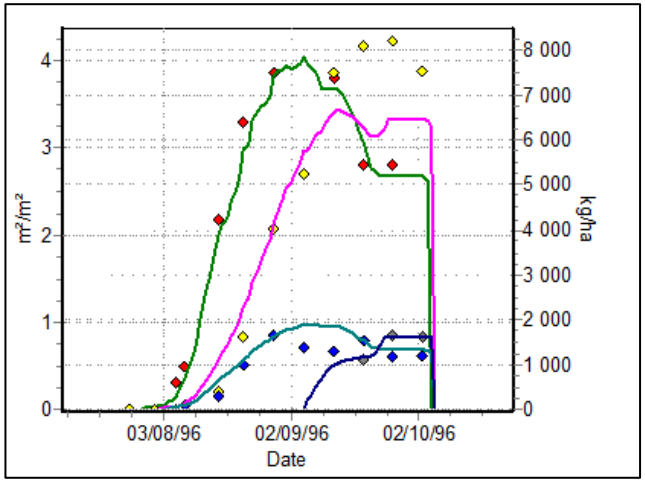
## Statistic data

**Millet Yield** – Aggregated at the Kollo department scale: 2000-2010 (AGRHYMET)

## Crop model : SARRA-H (*Baron et al., 2005*)

- Suited for the analysis of climate impact on cereal growth and yield in dry environment
- Operating at daily time step
- Simulates attainable yields and biomass at the field scale under **climatic constraint**




*Source : sarra-h.teledetection.fr*

Data & Methods



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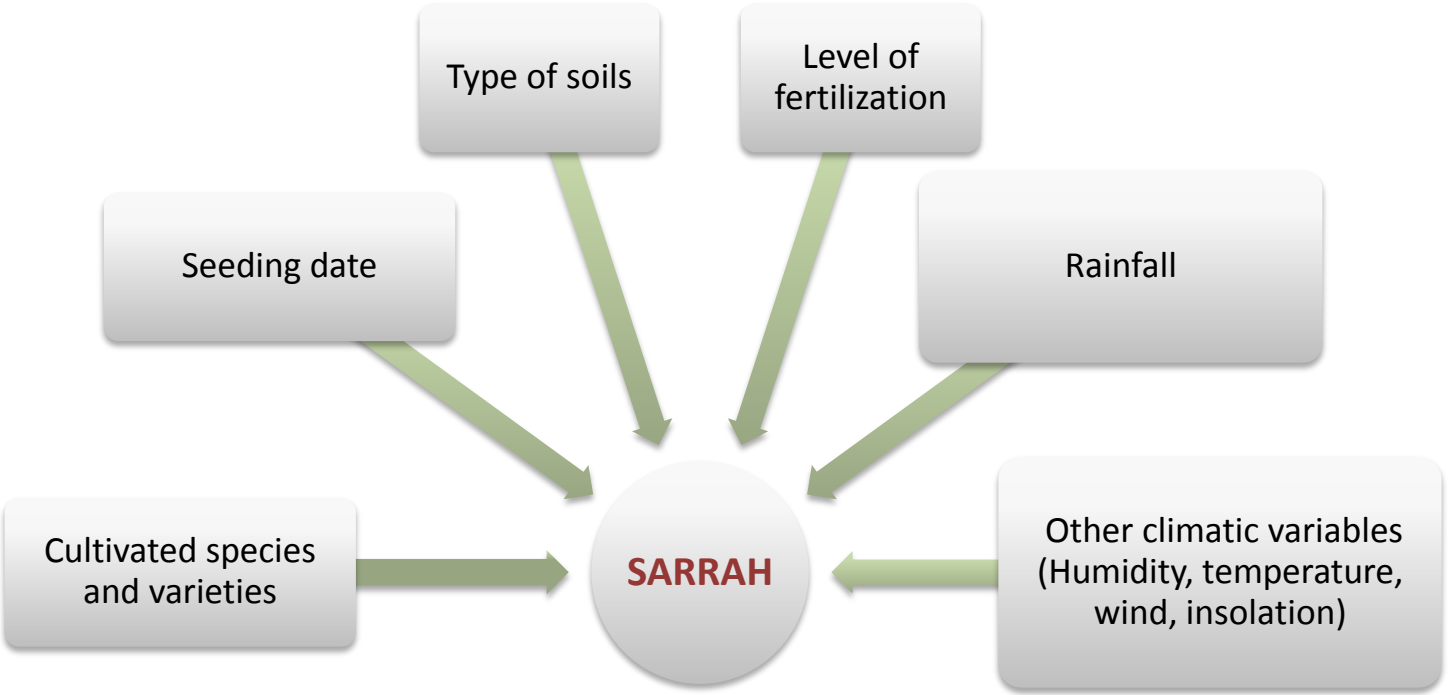

Data & Methods

Regional scale

Local scale

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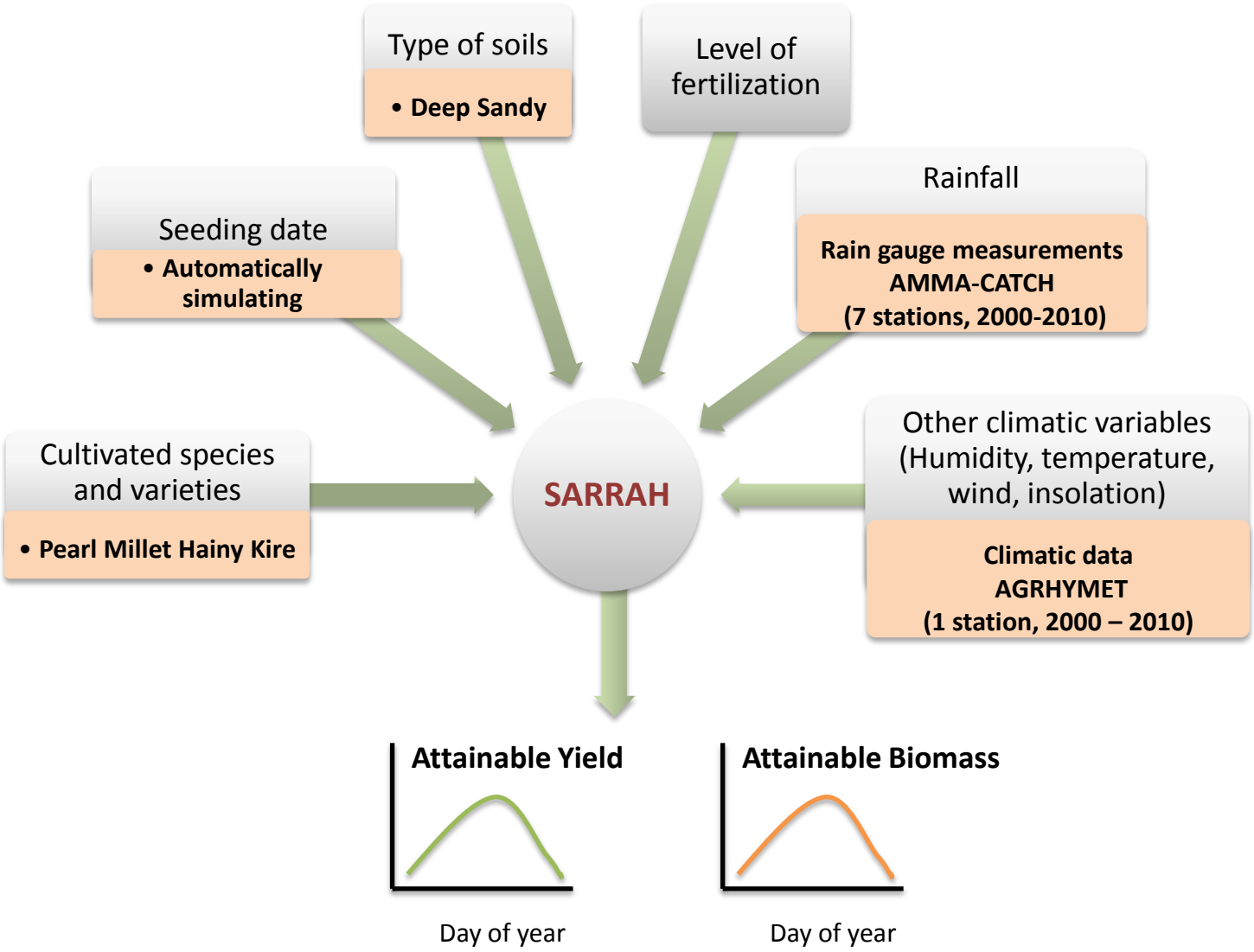


Data
&
Methods

*Regional scale*


## What does vegetation monitoring by remote sensing tells us about crop production dynamics?

Data & Methods

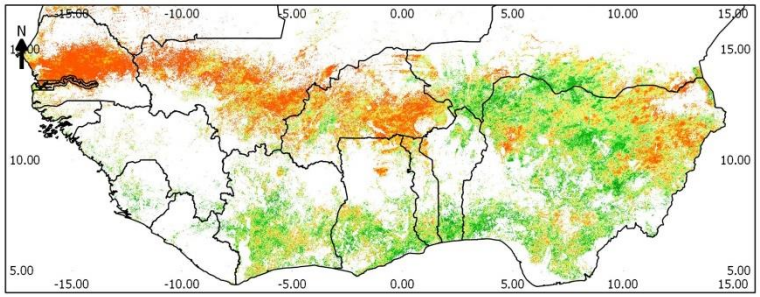
*Regional scale*

*Local scale*

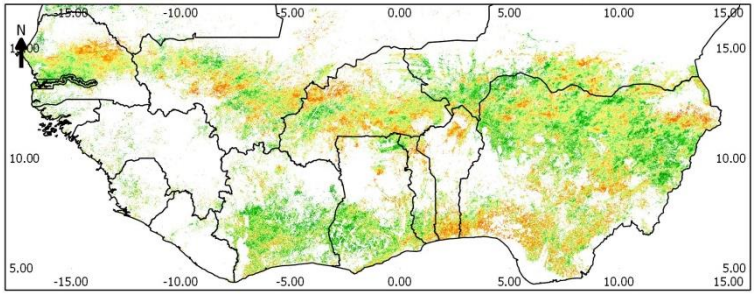
# What does vegetation monitoring by remote sensing tells us about crop production dynamics?

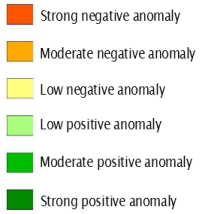
## NDVI anomalies between 2000 and 2012

NDVI anomaly 2002

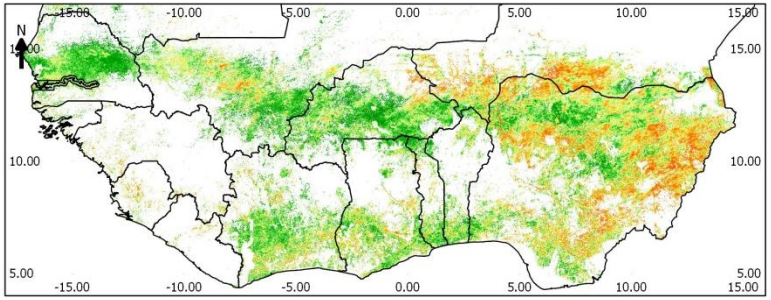



NDVI anomaly 2006




NDVI anomaly 2010

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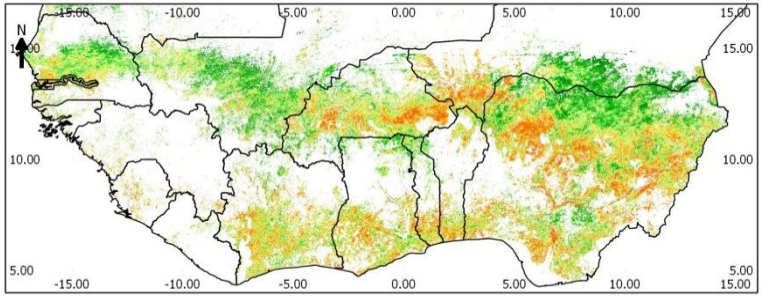
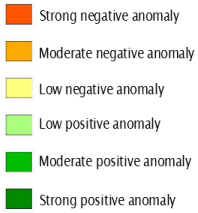



Strong spatio-temporal variability of biomass production within the crop domain:

→ vegetation stress ≈ decrease in biomass production

Data & Methods

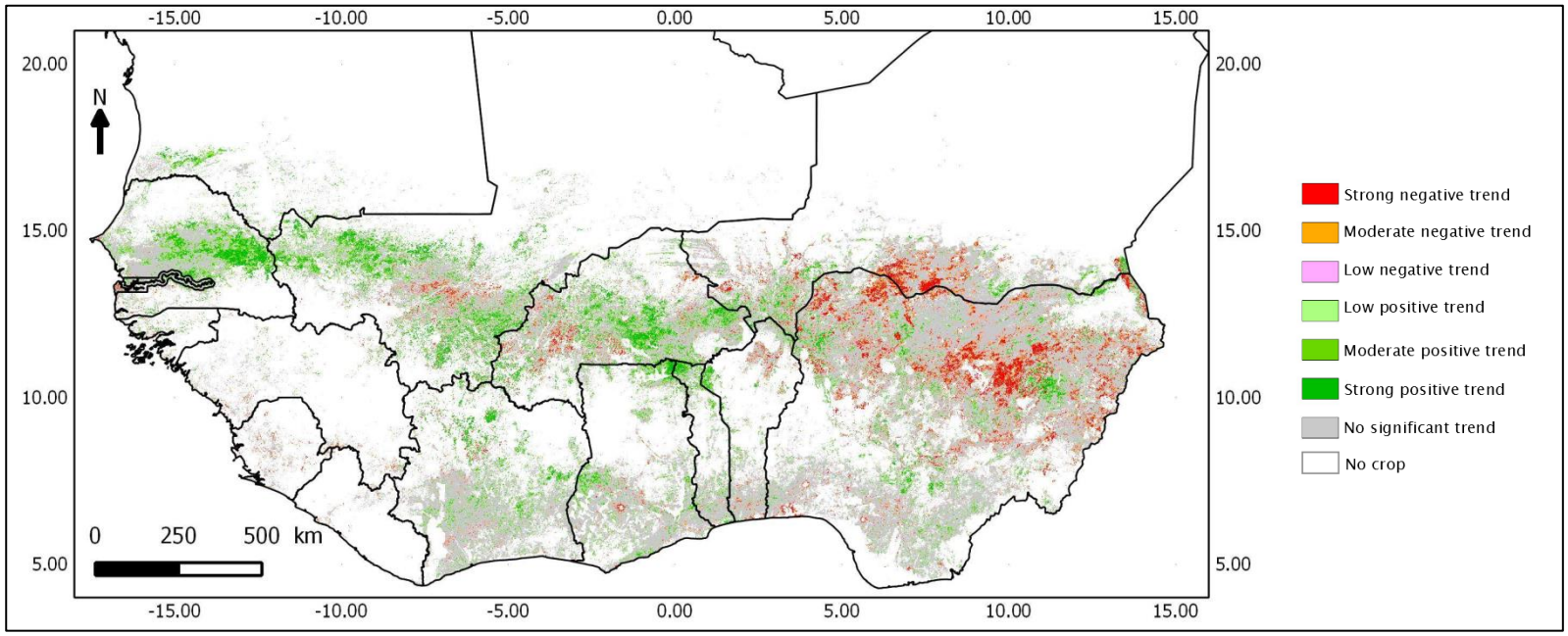
Regional scale

Local scale

# What does vegetation monitoring by remote sensing tells us about crop production dynamics?

## NDVI trends between 2000 and 2010 in West Africa

NDVI MODIS trends – significant at 90%




- Stable overall trend

Data & Methods

*Regional scale*

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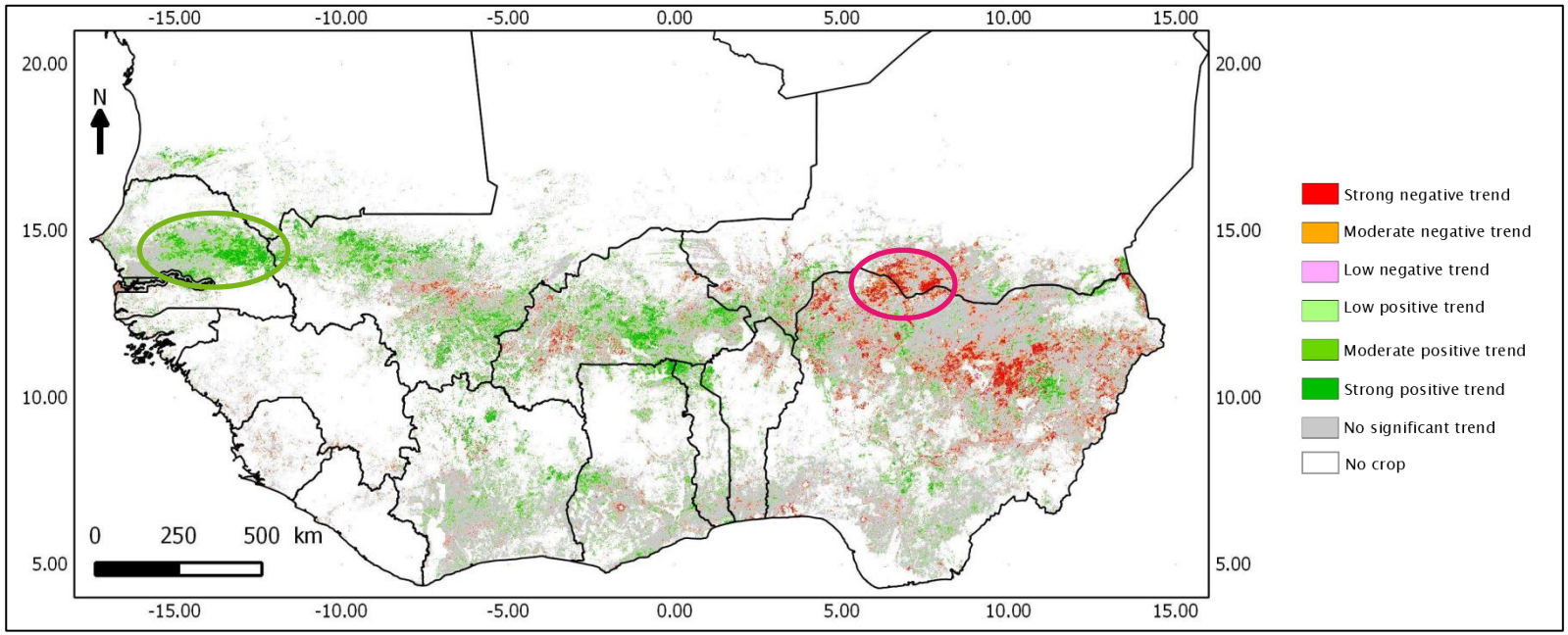


- Stable overall trend
- Identification of areas with:

- a significant increase in biomass production
- a significant decrease in biomass production

Data & Methods

*Regional scale*

*Local scale*

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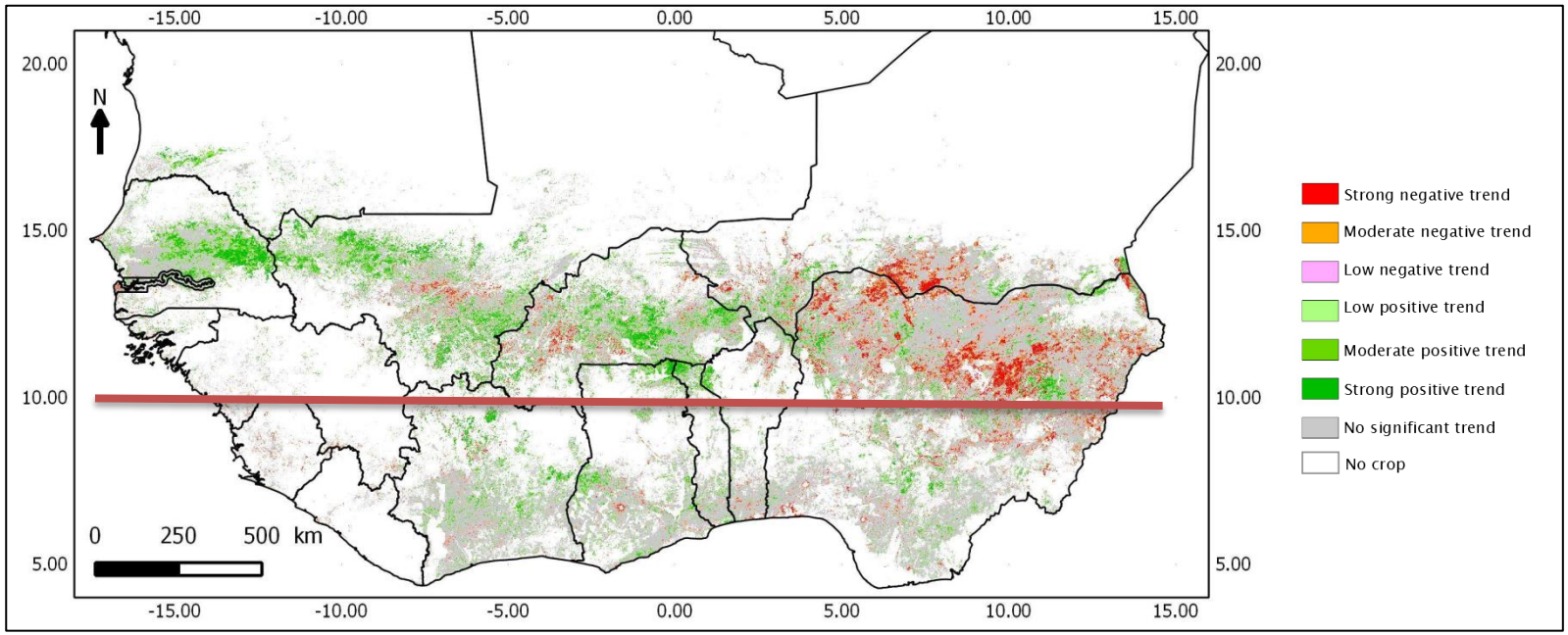


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- North/South effect
- East/West effect

Data & Methods

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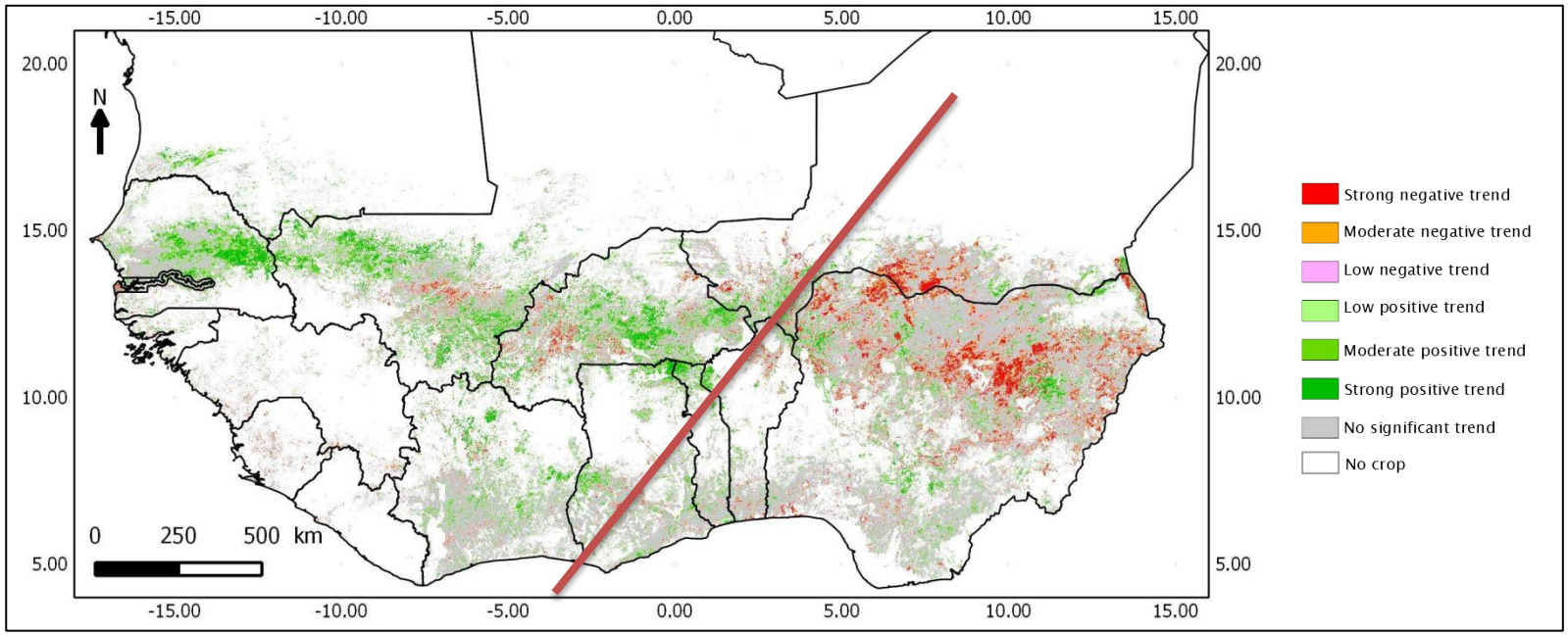


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Data & Methods

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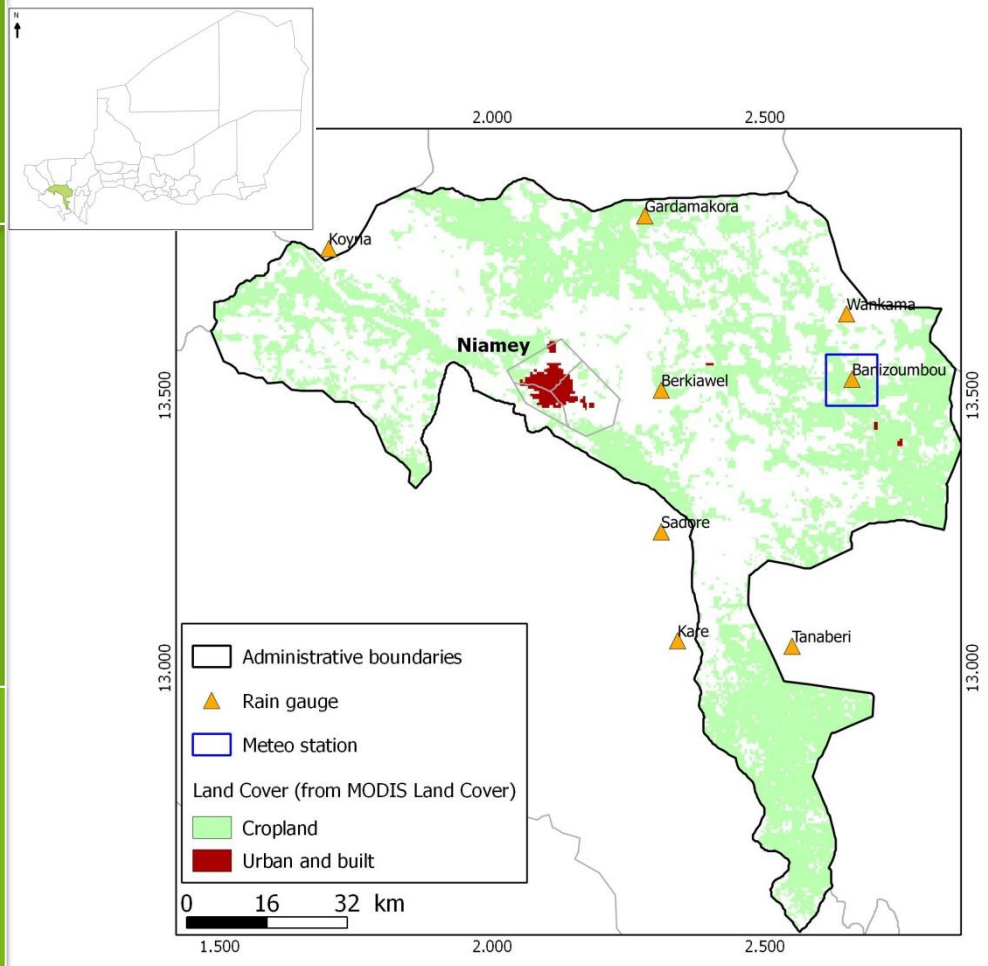
# *What does vegetation monitoring by remote sensing tells us about crop production dynamics?*

## Study area




- Centered on 13.5°N and 2.5°E
- Area of 10,000 km²
- Rainy season from **June to September**
  - 200-400mm/year
  - Sahelian climate
- Rainfed agriculture dominated by **pearl millet** (low input and low yield)

*Site instrumented since 1990's : availibility of climate and meteorogical daily time series*

Data & Methods

Regional scale

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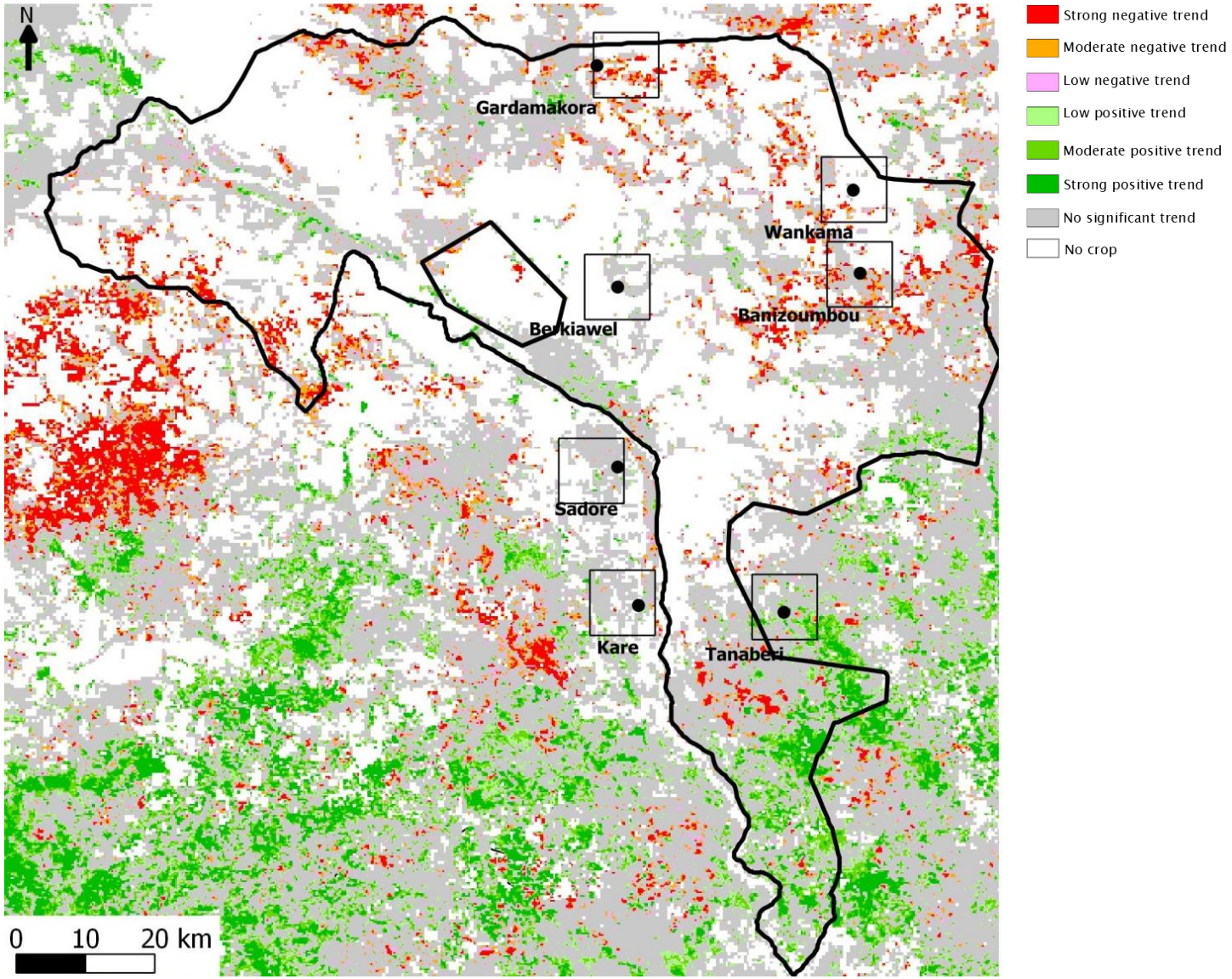

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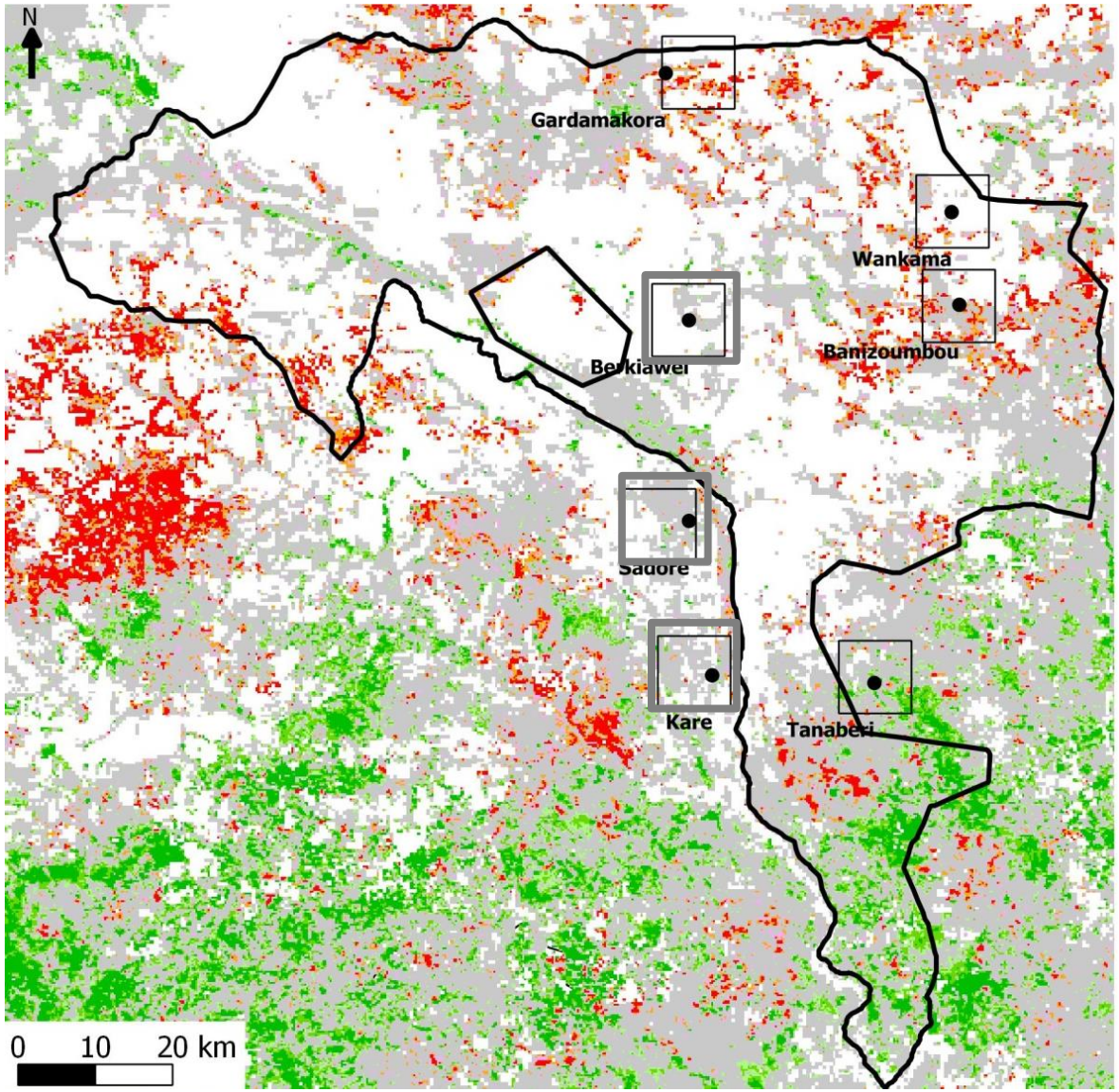

Data & Methods

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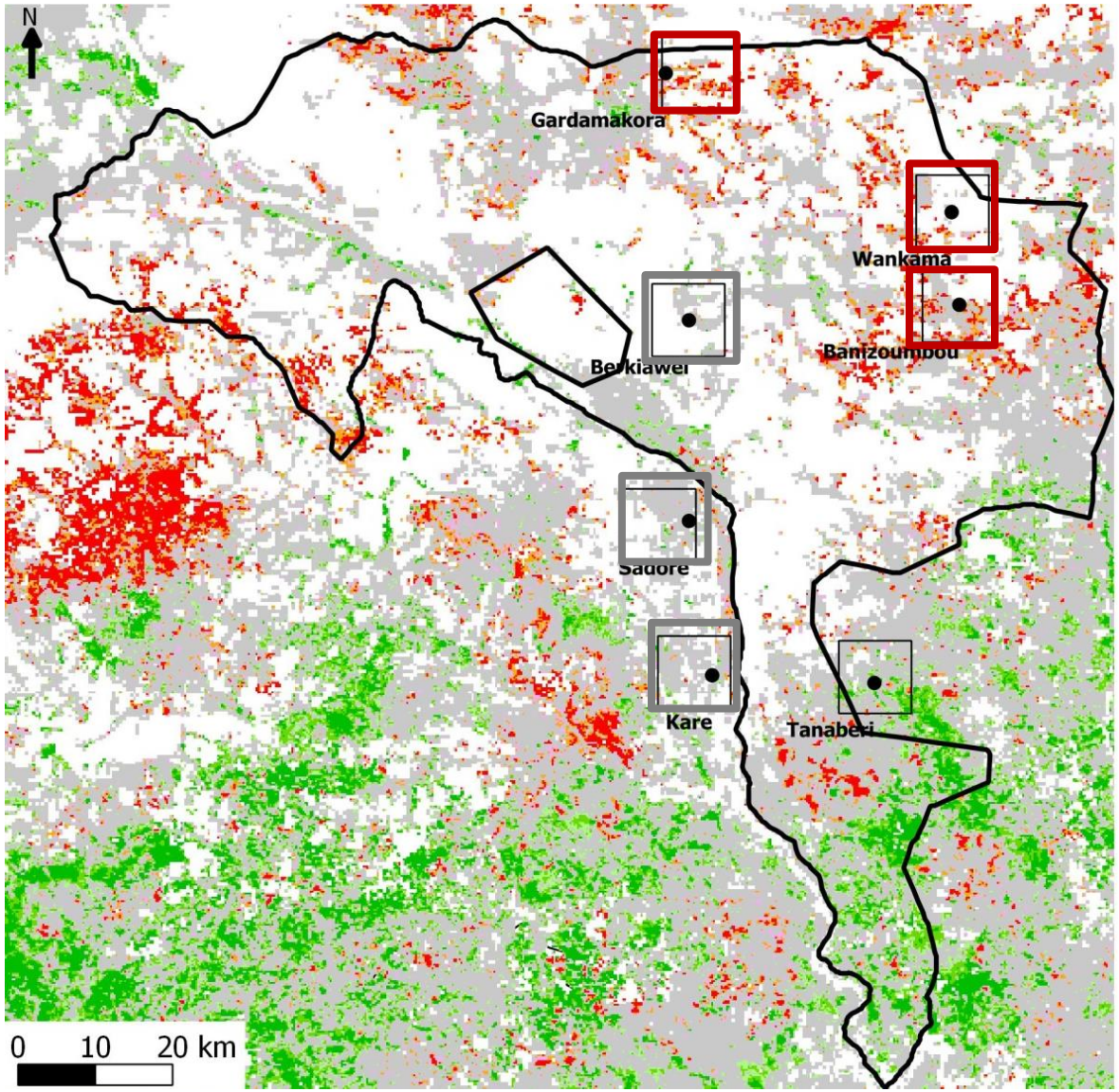

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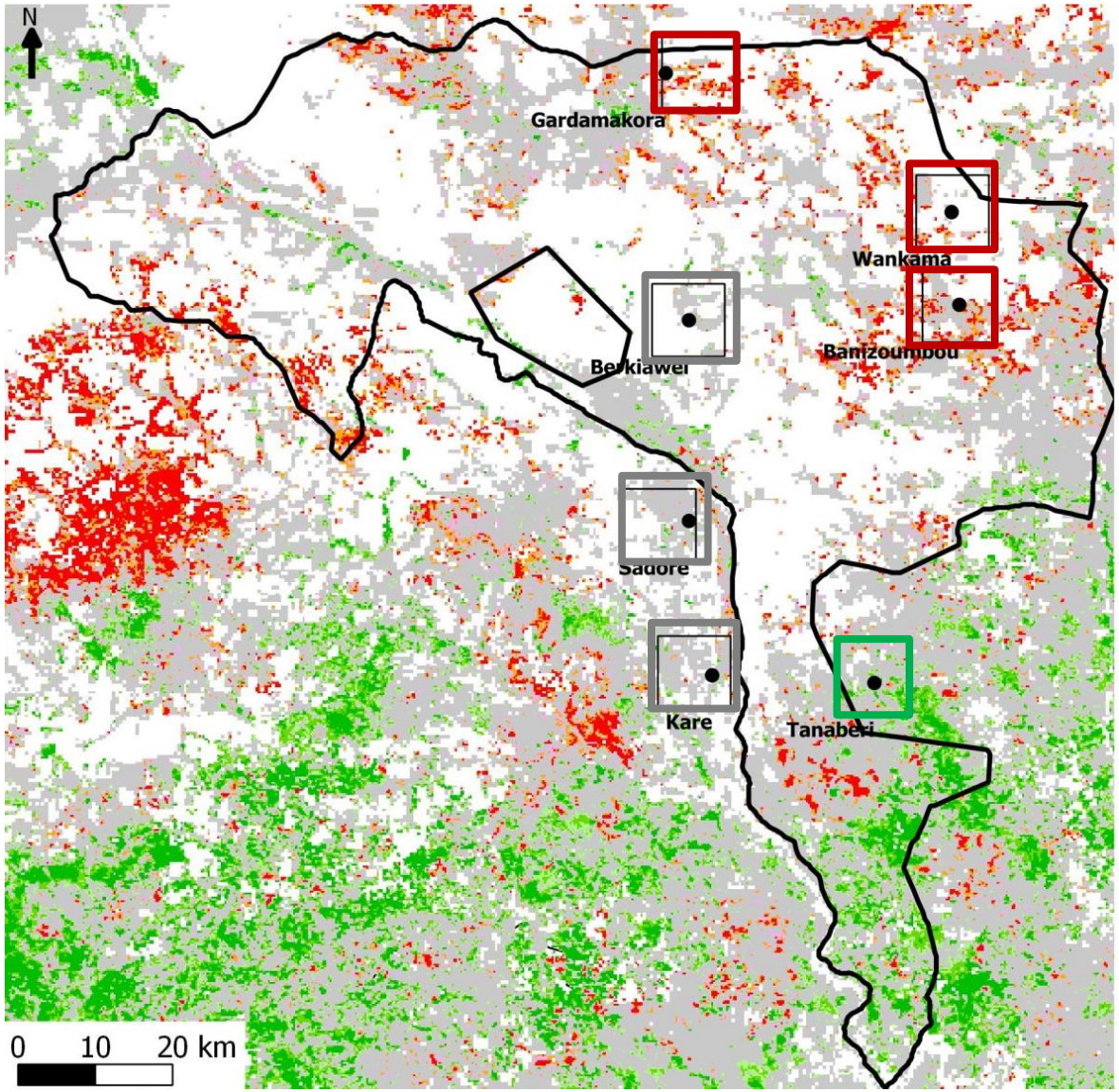

Data
&
Methods

*Regional scale*

*Local scale*

## Are the SARRA-H simulated yields and biomass in agreement with estimation from remote sensing?

Data & Methods

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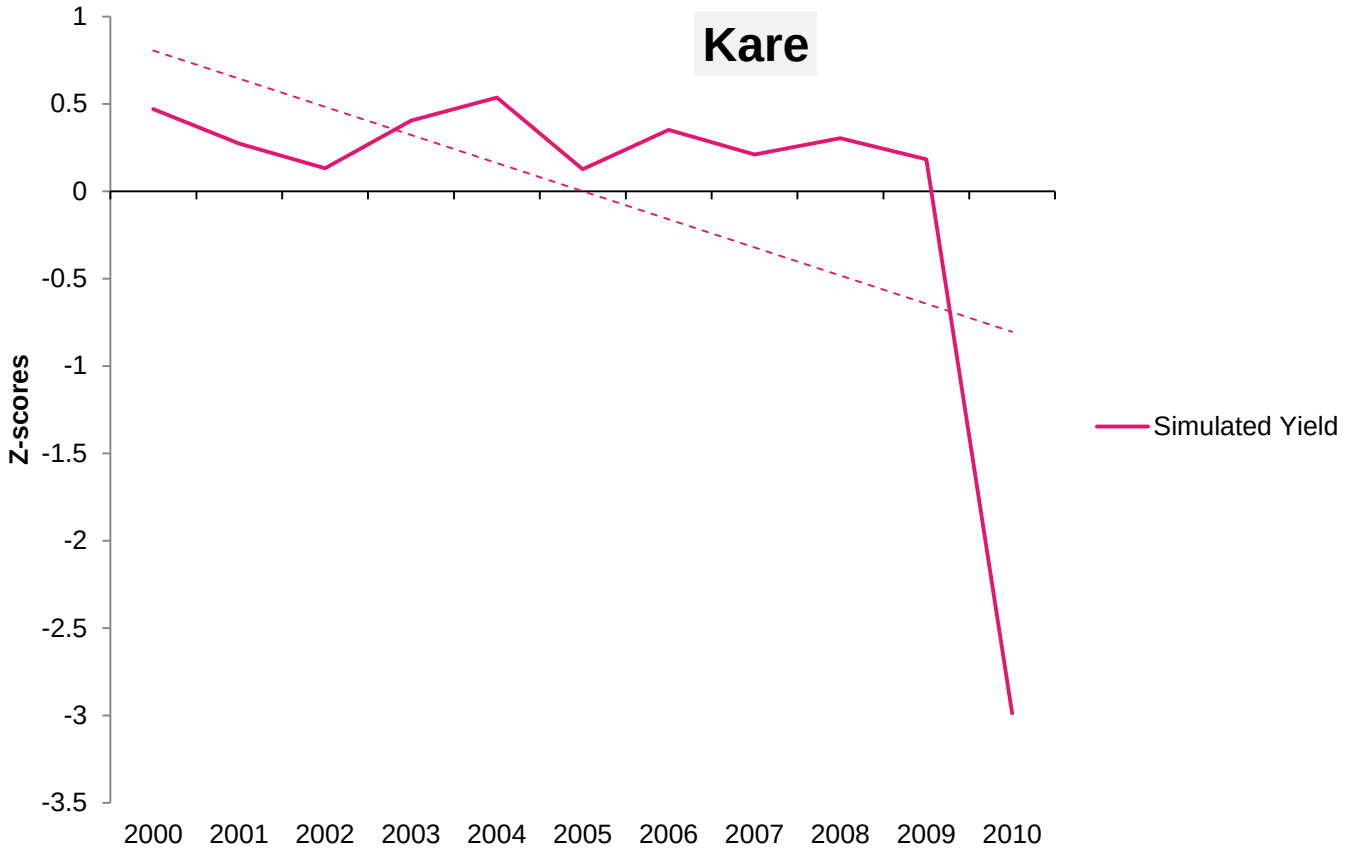

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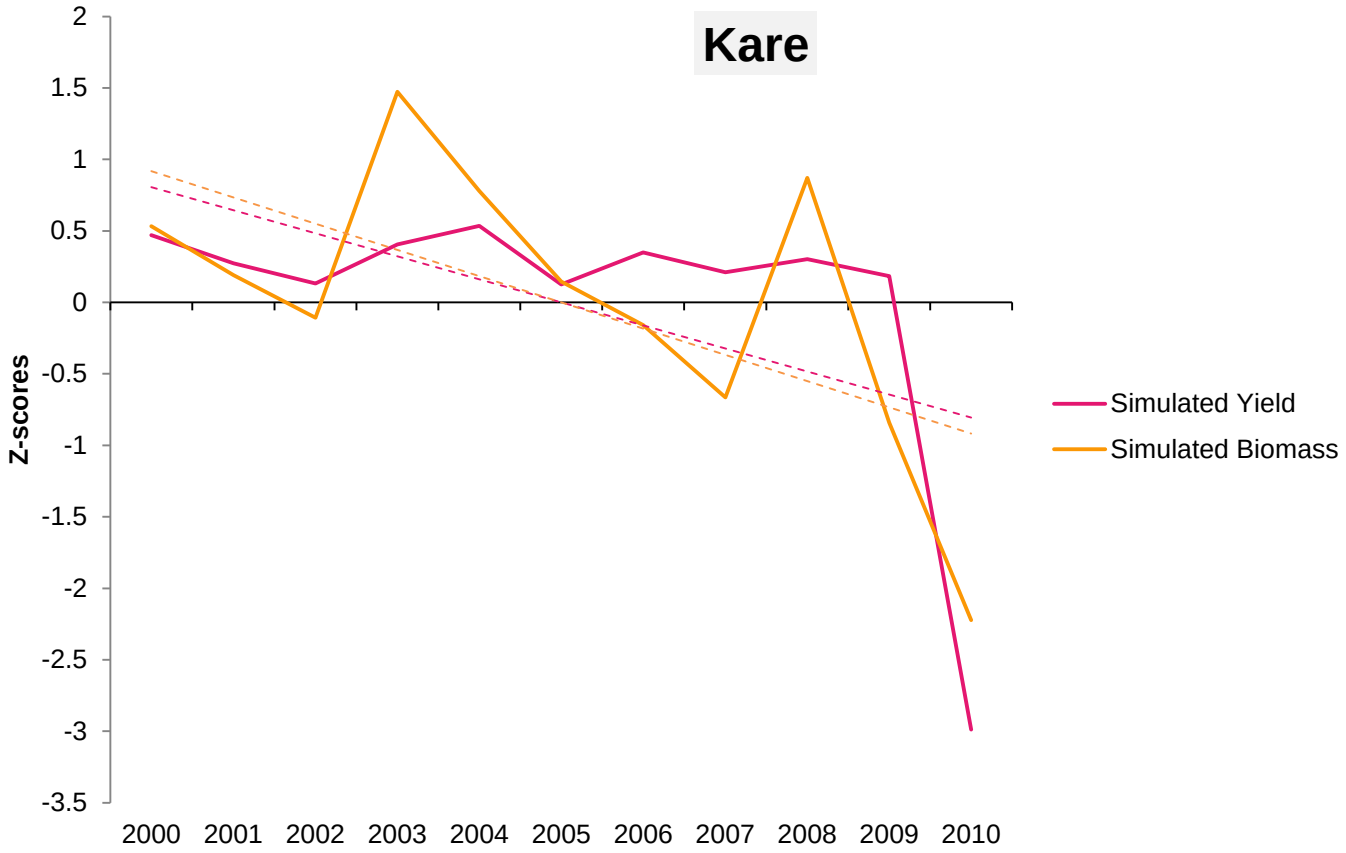

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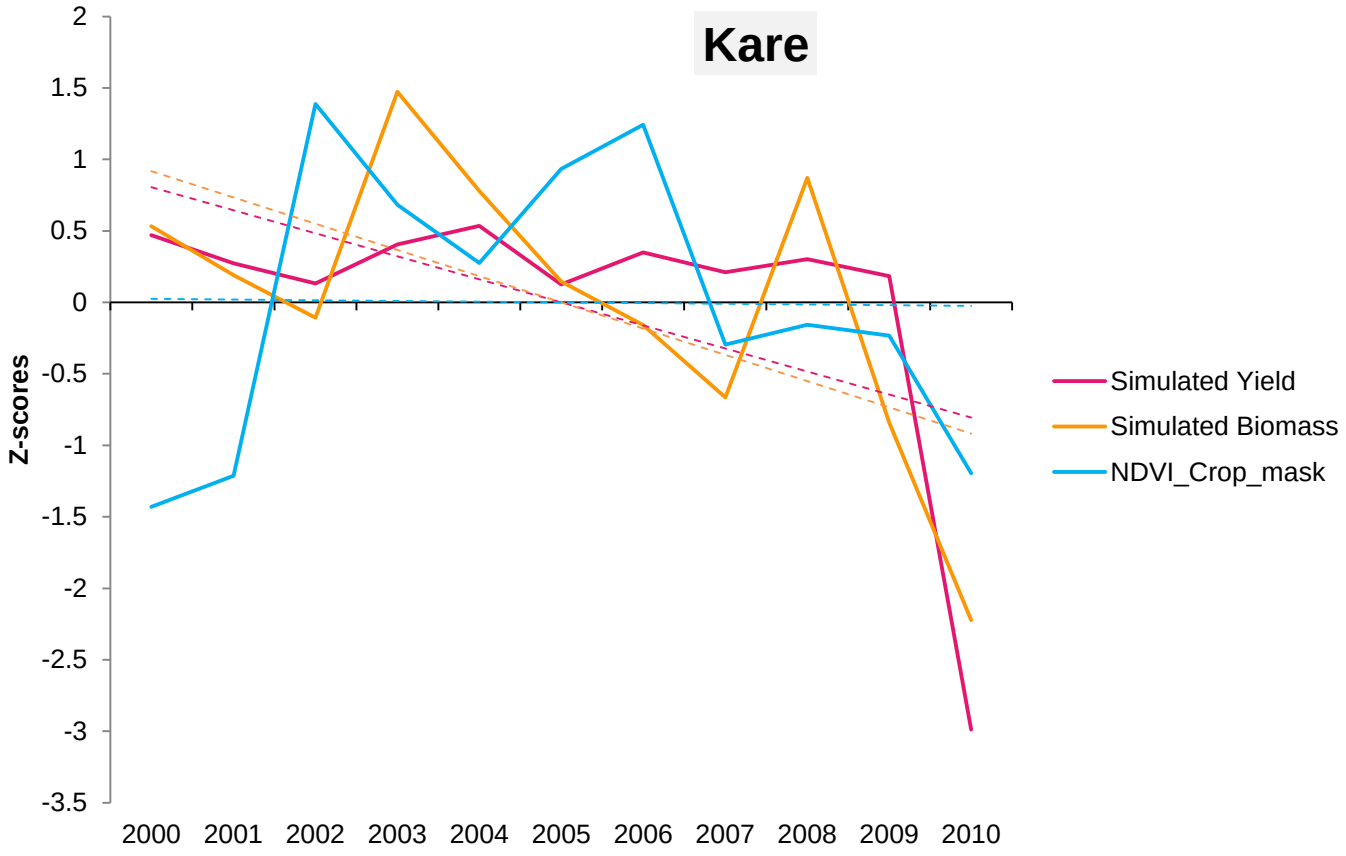

Data & Methods

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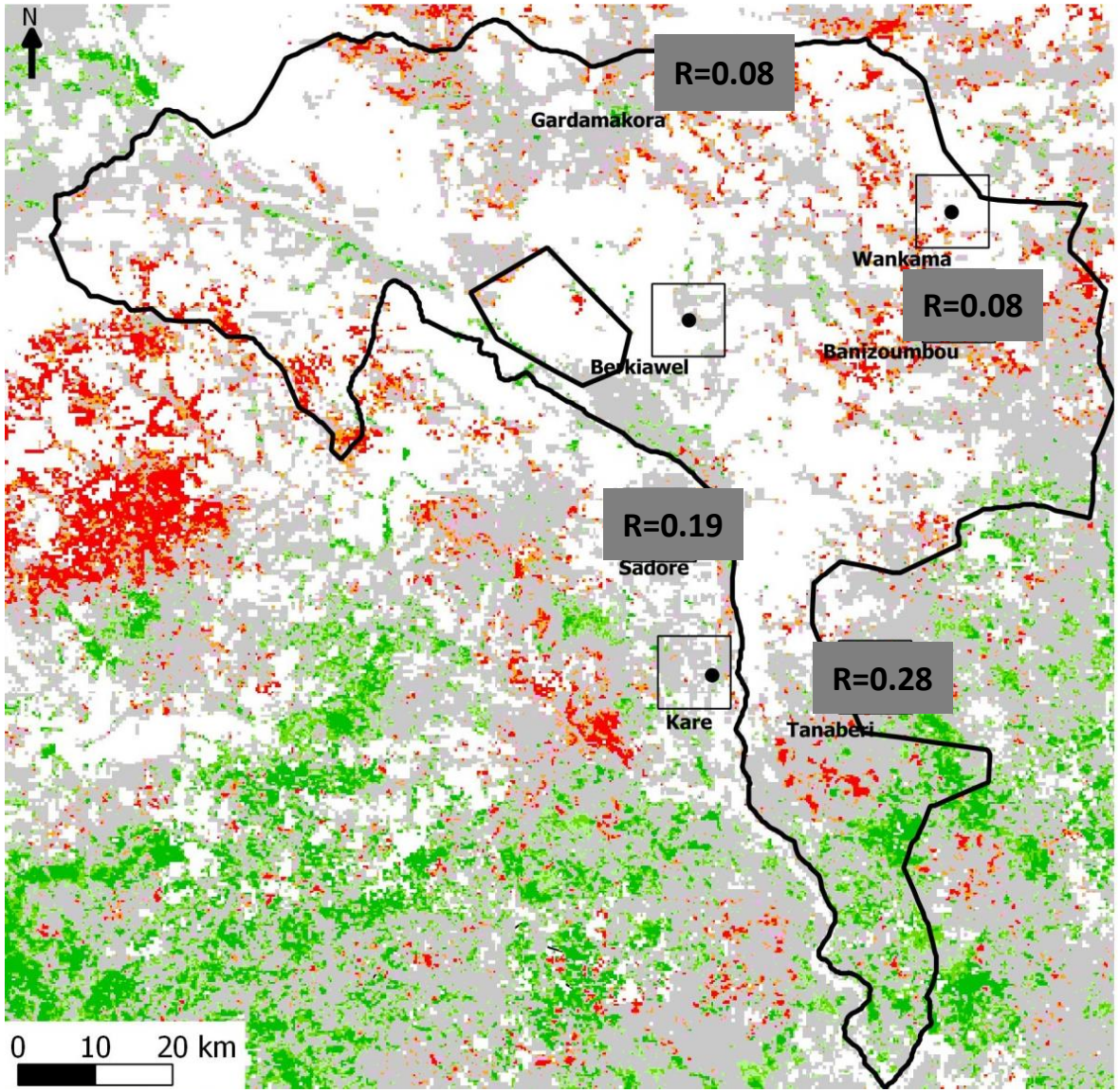

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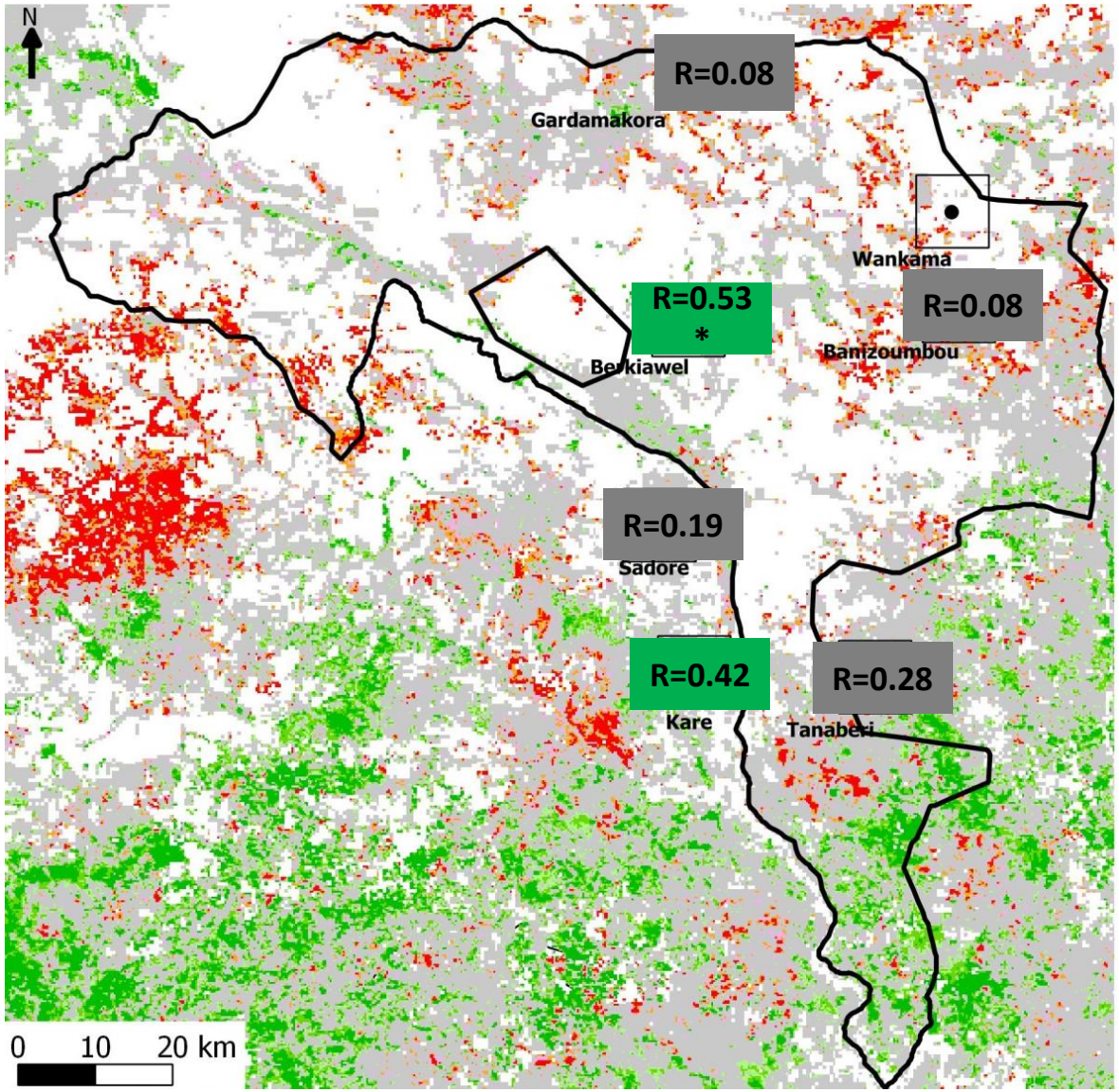

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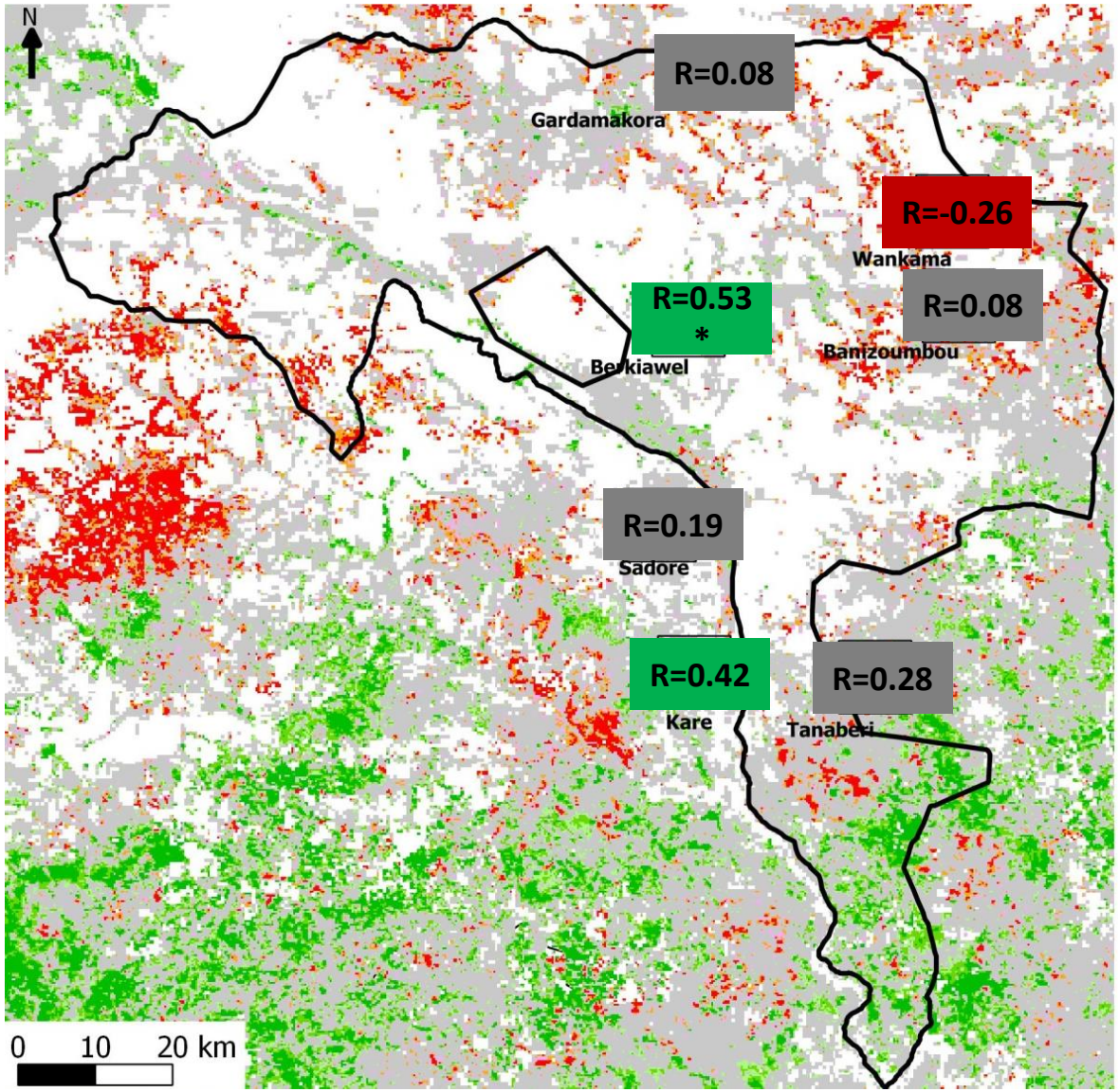

Data & Methods

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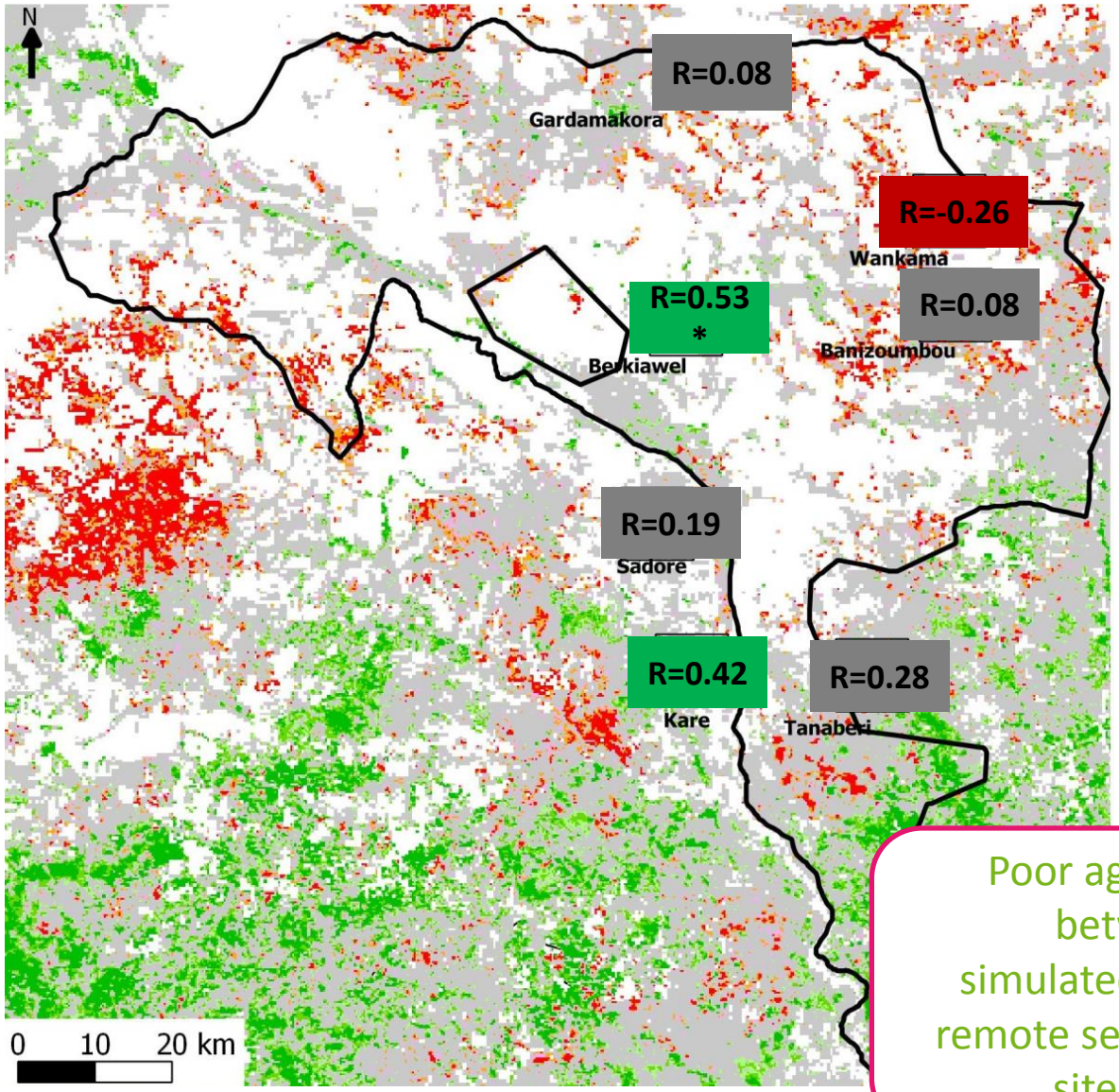


Poor agreement between simulated data and remote sensing at the site scale

Data & Methods

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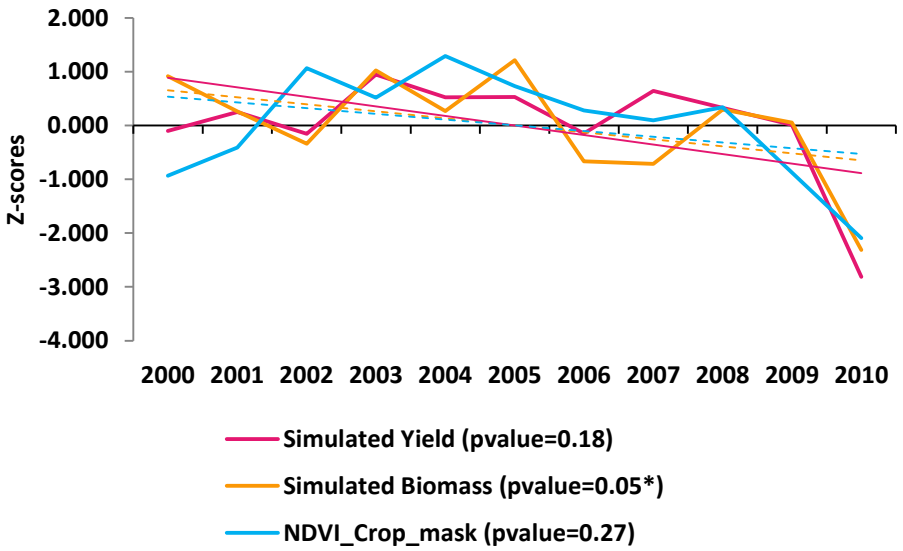


Data aggregation of 7 stations

- No significant trends (pvalue>0.10)

Data & Methods

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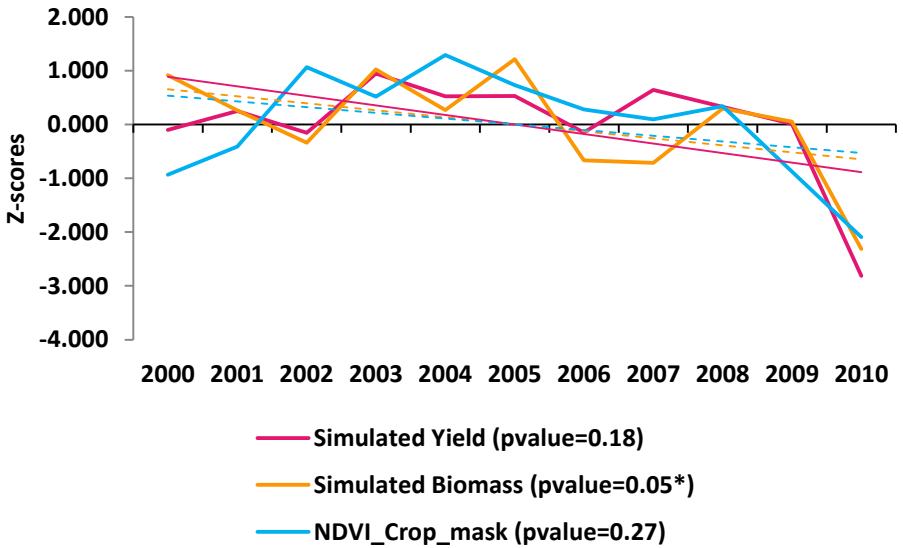


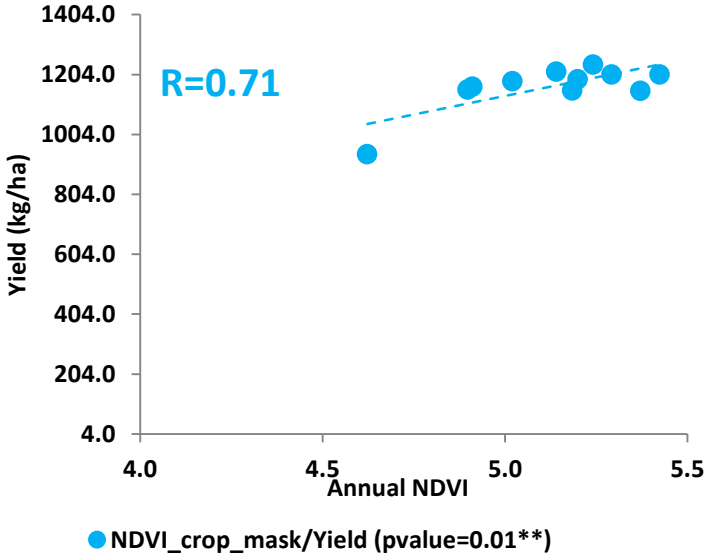


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Data & Methods

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Local scale

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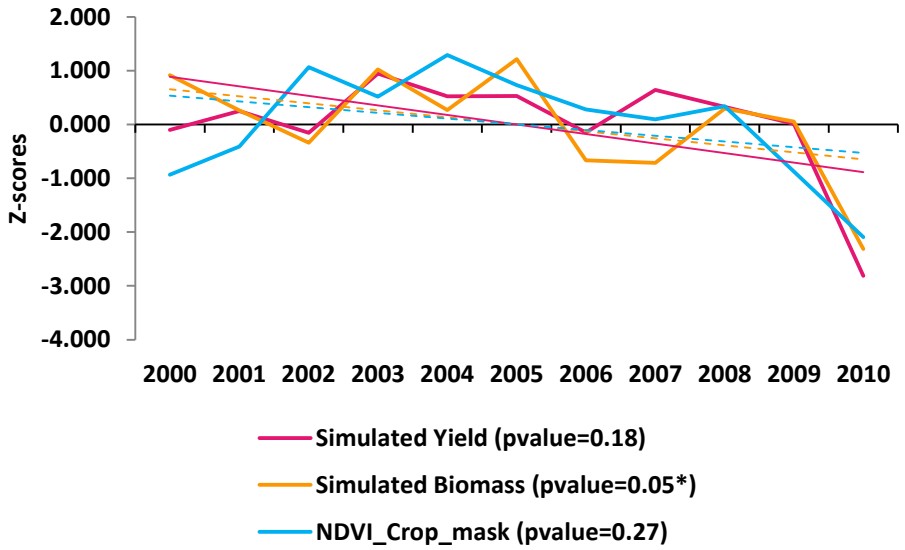


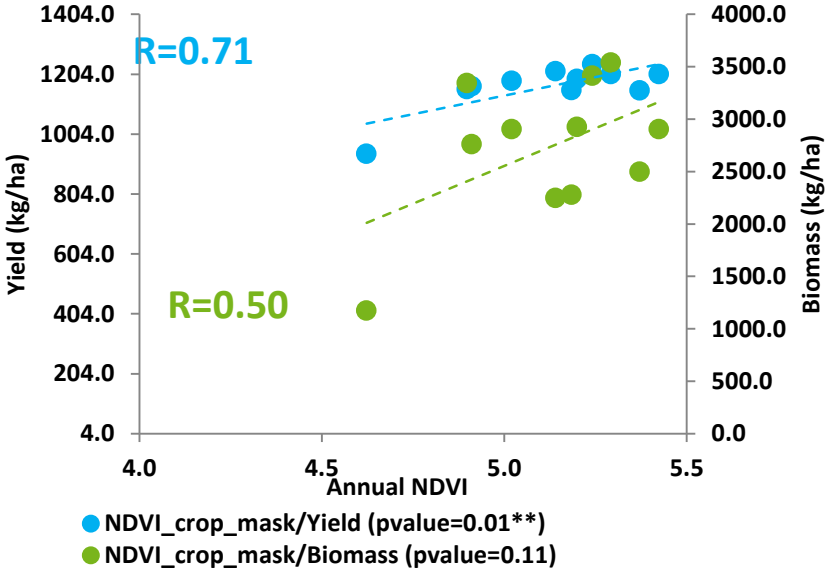


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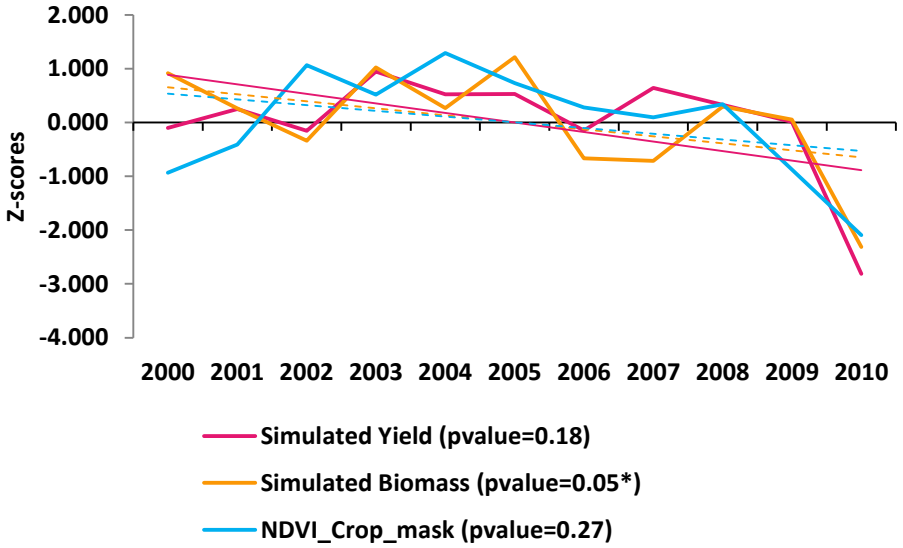


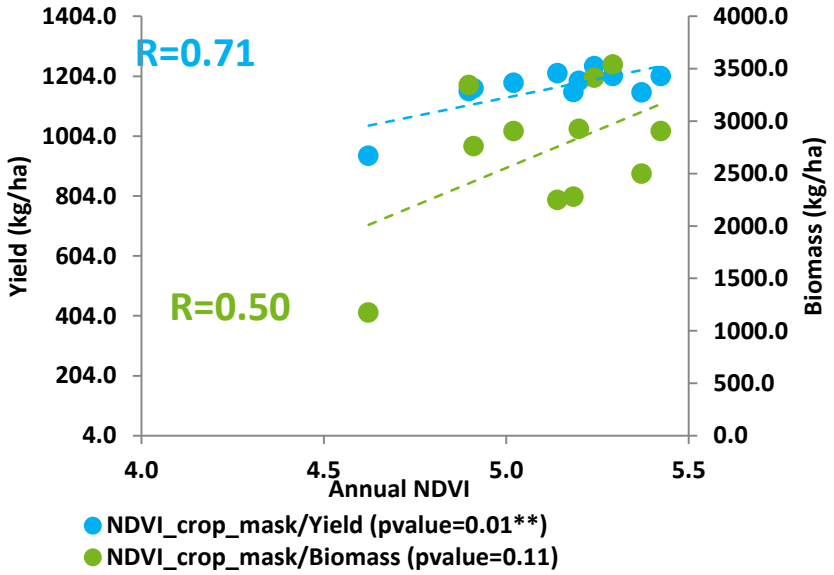


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- Good overall correlation between NDVI vs simulated data

Both satellite and simulation observations show **no significant trends**

**Good overall agreement**

Data
&
Methods

*Regional scale*

*Local scale*

## What do the statistics data say? Comparison between NDVI, simulated data and yields from AGRHYMET

Data & Methods

Regional scale

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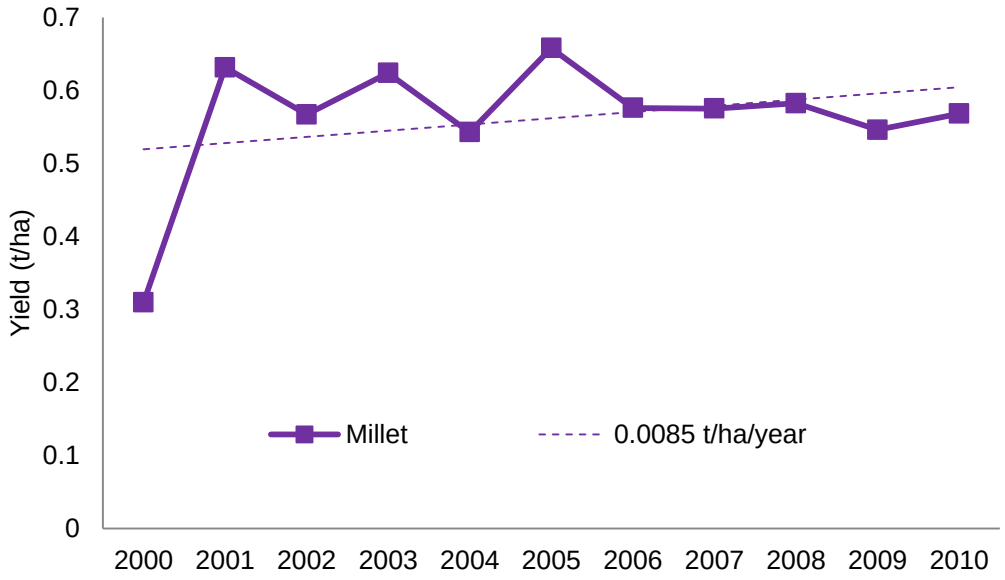


- Statistic data show a positive but no significant trend of millet yields

Data & Methods

Regional scale

Local scale

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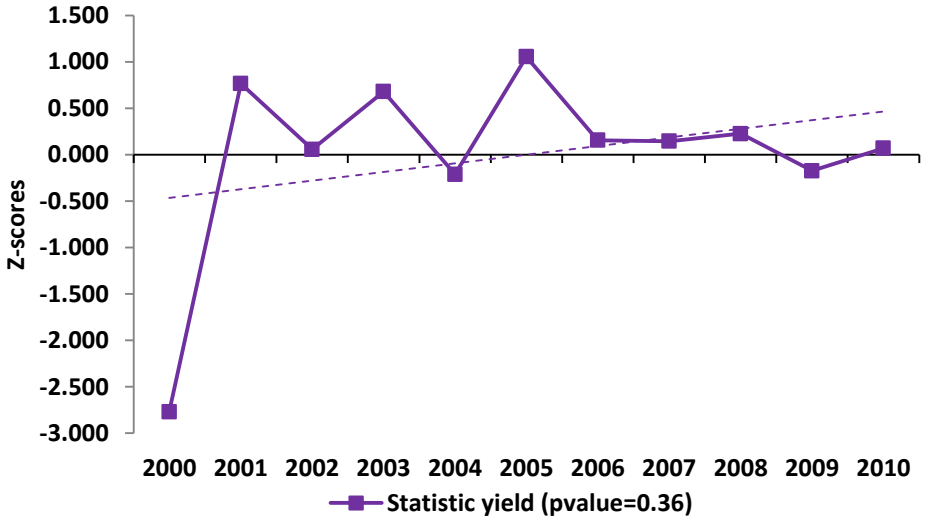
## Comparison at the Kollo department scale- *Between 2000 and 2010*




- *Statistics vs Satellite* : Opposite trends

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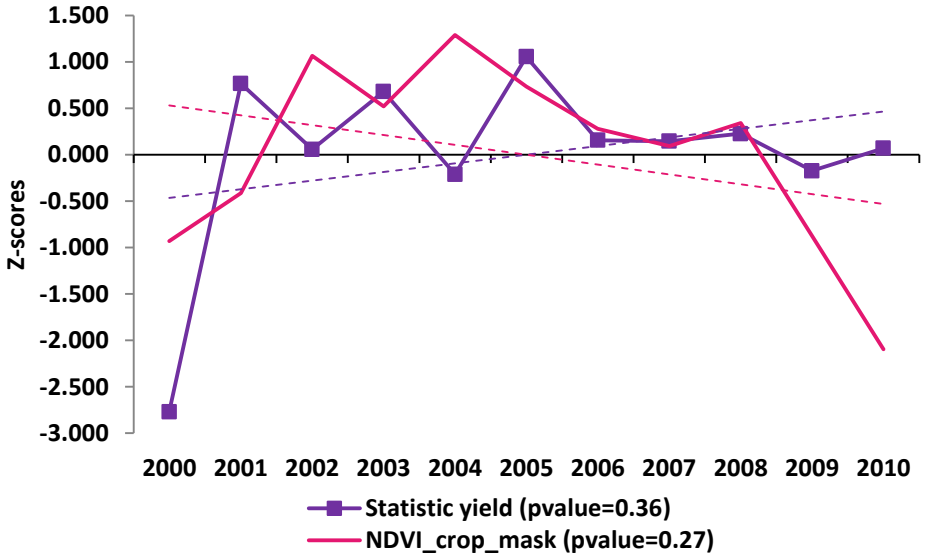


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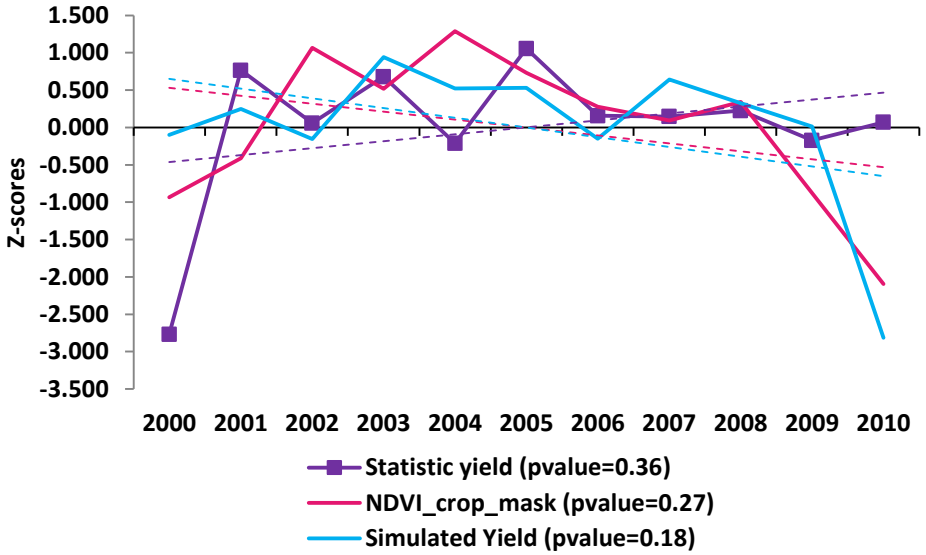


- *Statistics vs Satellite* : Opposite trends
- *Statistics vs Simulation* : Overall the same year-to-year variability but opposite trends

Data & Methods

Regional scale

Local scale

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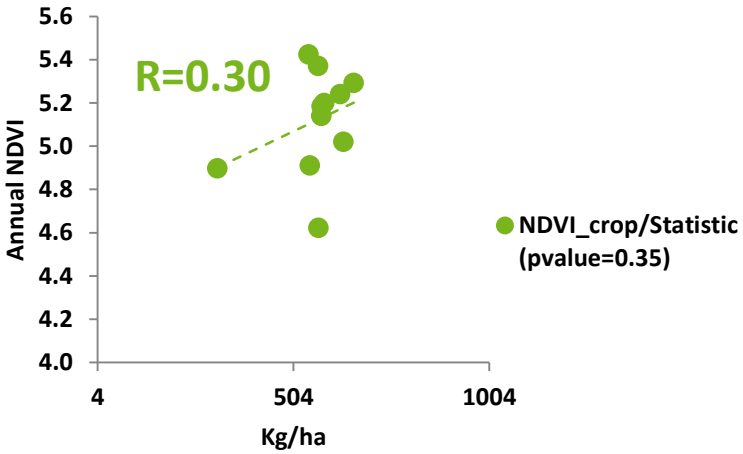


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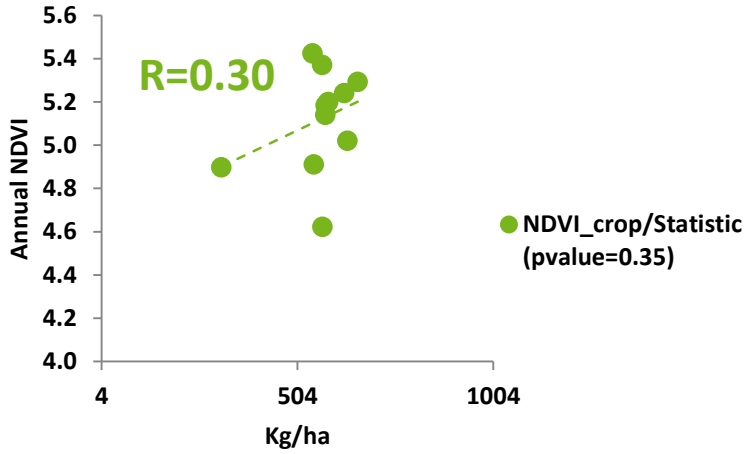


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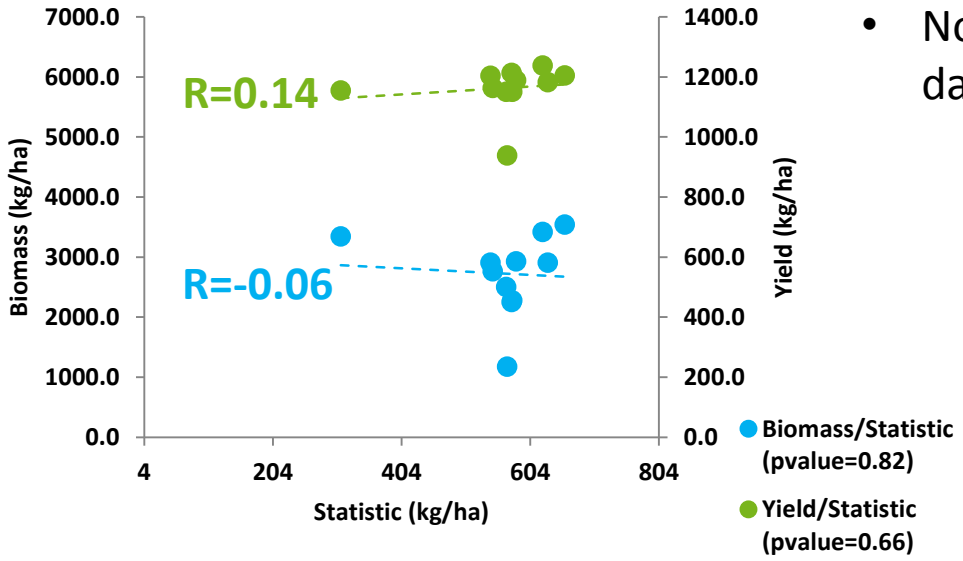


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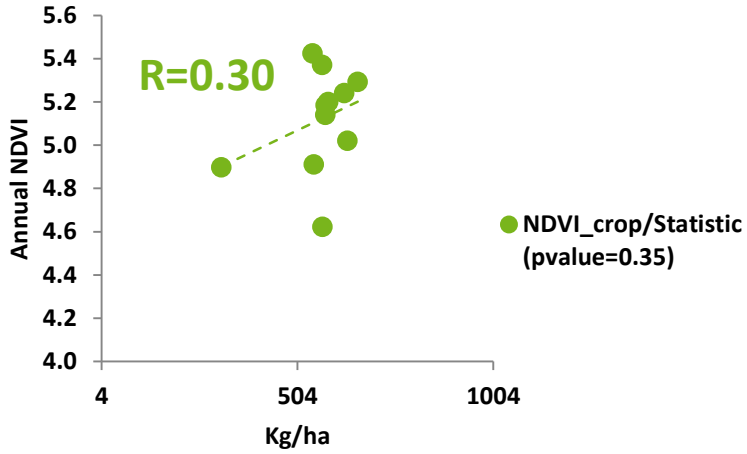


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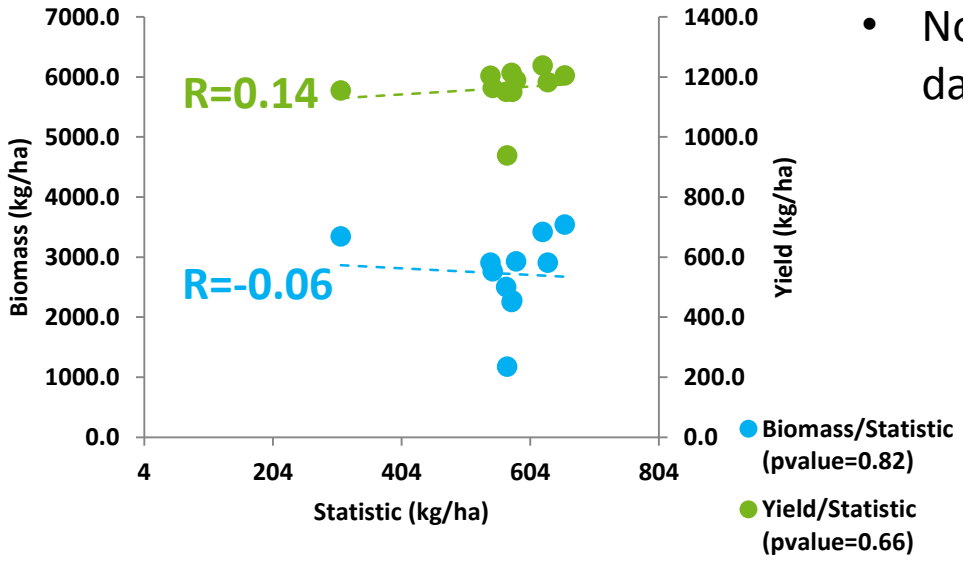


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**Opposite trends** but no significant

**No significant agreement**

# Conclusion and Perspectives

## At regional scale

- Satellite observations show an overall stable dynamic of the crop vegetation between 2000 and 2010
    - ✓ Limitations : Only 10 years of data
    - ✓ What about the long term crop vegetation trends? (NDVI GIMMS3g)

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- Poor agreement with statistic data
  - ✓ Weakness of aggregated statistic data : lack of spatial representativeness

Thank you for listening...